WHAT IS CLAIMED IS:

1. A shape memory alloy actuator array comprising:

a plurality of individually trained shape memory alloy actuators to provide relative movement of different actuator array portions; and

a thin-film heating element positioned adjacent at least one shape memory alloy actuator to thermally activate the actuator for movement away from its initial shape.

2. The shape memory alloy actuator array as recited in claim 1 wherein the actuators are positioned in between at least two connecting rings each defined by an outer periphery.

3. The shape memory alloy actuator array as recited in claim 2 wherein the actuators are positioned in between a plurality of connecting rings to form a generally columnar array.

4. The shape memory alloy actuator array as recited in claim 2 wherein at least one shape memory alloy actuator is positioned adjacent another shape memory alloy actuator along a different portion of the connecting rings.

45

5. The shape memory alloy actuator array as recited in claim 4 wherein at least one actuator expands towards a predetermined shape when heated.

6. The shape memory alloy actuator array as recited in claim 4 wherein at least one actuator contracts towards a predetermined shape when heated.

7. The shape memory alloy actuator array as recited in claim 4 wherein at least one actuator acts in opposition to at least one other actuator.

8. The shape memory alloy actuator array as recited in claim 2 wherein the shape memory alloy actuators are positioned in side by side pairs along the periphery of the connecting rings.

9. The shape memory alloy actuator array as recited in claim 8 wherein one actuator from each actuator pair expands from an initial shape towards a predetermined shape when heated.

10. The shape memory alloy actuator array as recited in claim 8 wherein one actuator from each actuator pair contracts from an initial shape towards a predetermined shape when heated.

11. The shape memory alloy actuator array as recited in claim 2 wherein each shape memory alloy actuator is positioned in side by side pairs with a biasing element for returning the actuator to its initial shape.

12. The shape memory alloy actuator array as recited in claim 11 wherein the biasing element is another actuator.

13. The shape memory alloy actuator array as recited in claim 11 wherein the biasing element is a shape memory alloy actuator trained with a predetermined shape.

14. The shape memory alloy actuator array as recited in claim 11 wherein the biasing element is formed of an elastomer.

15. The shape memory alloy actuator array as recited in claim 11 wherein the biasing element is a spring.

16. The shape memory alloy actuator array as recited in claim 1 wherein at least one actuator has an initial nonplanar shape and a substantially planar predetermined shape.

17. The shape memory alloy actuator array as recited in claim 1 wherein at least one actuator has an initial buckled shape and a substantially planar predetermined shape.

18. The shape memory alloy actuator array as recited in claim 1 wherein at least one actuator is configured with a substantially planar initial shape and a substantially planar predetermined shape of a relatively different length.

19. The shape memory alloy actuator array as recited in claim 1 wherein the array includes at least one actuator that contracts from an initial shape when heated and at least one actuator that expands from an initial shape when heated.

20. The shape memory alloy actuator array as recited in claim 19 wherein the number of actuators in the array that contract towards a predetermined shape when heated is equal to the number of actuators in the array that expand towards a predetermined shape when heated.

21. The shape memory alloy actuator array as recited in claim 1 wherein at least one actuator may be heated to move away from its initial shape to an intermediate shape.

22. The shape memory alloy actuator array as recited in claim 1 wherein a selected combination of at least one actuator may be heated to provide for variable stiffness of the shape memory alloy actuator array.

23. A shape memory alloy catheter comprising:

a catheter body formed with a sidewall portion;

a shape memory alloy portion positioned adjacent the catheter sidewall portion having a lattice network of individually configured shape memory alloy micro-actuators; and

an addressable thin-film heater element in communication with the shape memory alloy portion for activation of selected micro-actuators.

24. The shape memory alloy catheter as recited in claim 23 wherein the micro-actuators are arranged in segmented joints.

25. The shape memory alloy catheter as recited in claim 24 further including connecting rings for separating the micro-actuators into segmented joints.

Sub C1

26. The shape memory alloy catheter as recited in claim 25 wherein the shape memory alloy portion includes at least one micro-actuator that expands

upon heating by an addressable heater element and at least one micro-actuator that contracts upon heating by another addressable heater element.

27. The shape memory alloy catheter as recited in claim 23 wherein the shape memory alloy portion includes at least one addressable heater element to heat a selected combination of at least one micro-actuator for varying the relative stiffness of the shape memory alloy portion.

3. ~~28.~~ The shape memory alloy catheter as recited in claim ~~27~~ 2 wherein the shape memory alloy portion may be thermally activated to have a different stiffness relative to the catheter sidewall portion.

Sub C2

29. The shape memory alloy catheter as recited in claim 23 wherein the shape memory alloy portion surrounds at least a portion of the catheter body.

30. The shape memory alloy catheter as recited in claim 23 further including a micro-fabricated sensor.

31. The shape memory alloy catheter as recited in claim 23 further including a micro-fabricated transducer.

46

Sub C3

32. The shape memory alloy catheter as recited in claim 23 wherein the shape memory alloy is NiTi.

33. A shape memory alloy conduit comprising:

a lattice structure formed of oppositely trained shape memory alloy micro-actuators substantially disposed between at least two connecting rings; and

a network of heating elements formed about the lattice structure for activating selected shape memory actuators within the lattice structure.

34. The shape memory alloy conduit as recited in claim 33 wherein the network of heating elements activates a selected combination of at least one actuator in the conduit to provide relative movement between conduit portions.

35. The shape memory alloy conduit as recited in claim 33 wherein the network of heating elements activates a selected combination of at least one actuator in the conduit to vary the relative stiffness of lattice structure portions.

36. The shape memory alloy conduit as recited in claim 33 further including at least two connecting members separating the conduit portions wherein the actuators are positioned in between the connecting members.

37. The shape memory alloy conduit as recited in claim 33 wherein the lattice structure includes at least one micro-actuator that expands when heated and at least one micro-actuator that contracts when heated.

38. The shape memory alloy conduit as recited in claim 33 wherein the network of heating elements are positioned along the connecting members and in communication with at least one micro-actuator.

39. The shape memory alloy conduit as recited in claim 38 further comprising a microprocessor unit wherein the heating elements are thin-film addressable heating elements controlled by the microprocessor unit that selectively activates a combination of at least one micro-actuator for relative movement of the shape memory alloy conduit.

40. The shape memory alloy conduit of claim 33 wherein the conduit forms at least a portion of a catheter.

41. The shape memory alloy conduit of claim 33 wherein the conduit forms at least a portion of an introducer.

42. The shape memory alloy conduit of claim 33 wherein the conduit forms at least a portion of a cannula.

43. A shape memory alloy medical device comprising:

a scaffolding formed of individually activated and oppositely trained shape memory alloy actuators set with a predetermined shape to provide a full range of directional movement within a body; and

at least thin-film one heating element in communication with the scaffolding surface to selectively activate a combination of at least one actuator towards a predetermined state.

44. The shape memory alloy medical device as recited in claim 43 wherein the scaffolding further includes at least two connecting rings to support relative movement of the shape memory alloy medical device.

45. The shape memory alloy medical device as recited in claim 44 wherein at least one actuator has a substantially rectangular configuration with a buckled surface longitudinally aligned relative to the scaffolding.

46. The shape memory alloy medical device as recited in claim 45 wherein a plurality of heating elements provide for a system of separately

addressable thin-film heaters that thermally activates a selected combination of at least one actuator to vary the ring to ring tilt angle of the scaffolding within a predetermined range.

47. The shape memory alloy medical device as recited in claim 44 wherein at least one actuator has a substantially rectangular configuration with a buckled surface laterally aligned relative to the scaffolding.

48. The shape memory alloy medical device as recited in claim 45 wherein a plurality of heating elements provide for a system of separately addressable thin-film heaters that thermally activates a selected combination of at least one actuator to vary the ring to ring rotational angle of the scaffolding within a predetermined range.

49. The shape memory alloy medical device as recited in claim 44 wherein the scaffolding includes at least one actuator with a substantially elongated configuration that is aligned relatively longitudinal to the scaffolding and at least one actuator with a substantially elongated configuration that is aligned relatively lateral to the scaffolding.

50. The shape memory alloy medical device as recited in claim 49 wherein a plurality of heating elements provide for a system of separately addressable thin-film heaters that thermally activates a selected combination of at least one actuator for relative movement of the device within the body.

51. The shape memory alloy medical device as recited in claim 43 wherein the heating element selectively activates at least one actuator in the scaffolding to an intermediate state.

52. A thermally activated directional actuator device comprising:

a skeletal structure formed of individual oppositely trained shape memory alloy actuators each configured with a predetermined shape; and

a heating system having individual localized heaters for moving each actuator towards its predetermined shape.

53. A thermally activated directional actuator device as recited in claim 52 wherein the skeletal structure further includes a shape memory alloy backbone.

54. A thermally activated directional actuator device as recited in claim 53 wherein the backbone includes a shape memory alloy portion that contracts

when thermally activated and a shape memory alloy portion that expands when thermally activated to provide for arcuate movement of the actuator device.

55. A thermally activated directional actuator device as recited in claim 54 wherein the skeletal structure is formed with a supporting ribbed cage section.

56. A thermally activated directional actuator device as recited in claim 55 wherein at least a portion of the directional actuator is encapsulated within a polymer coating.

57. A thermally activated directional actuator device as recited in claim 52 wherein the skeletal structure includes a plurality of intermediary spacers to form a directional actuator having a multiple stage configuration.

58. A thermally activated directional actuator device as recited in claim 57 wherein the intermediary spacers further includes actuator extensions for connection to actuators.

59. A thermally activated directional actuator device as recited in claim 58 wherein the intermediary spacers are connecting rings for supporting relative movement of the directional actuator portions.

60. A thermally activated directional actuator device as recited in claim 59 wherein the skeletal structure is formed with at least two oblong actuators longitudinally aligned relative to the actuator for relative movement of the skeletal structure portion.

61. A thermally activated directional actuator device as recited in claim 59 wherein the skeletal structure is formed with at least two oblong actuators laterally aligned relative to the actuator for relative movement of the skeletal structure portion.

62. A thermally activated directional actuator device as recited in claim 61 wherein the connecting rings are formed with actuator extensions for connecting actuators laterally aligned relative to the actuator device.

63. A thermally activated directional actuator device as recited in claim 62 wherein the laterally aligned actuators include at least one actuator that expands in length when heated and at least one actuator that contracts in length when heated.

::ODMA\PCDOCS\SQL1\184519\1

64. A method of forming a shape memory alloy actuator array comprising the following steps of:

selecting a sheet of shape memory alloy material defined by at least two side edges;

forming a plurality of shape memory alloy actuators to provide relative movement of the actuator by removing selected window portions of the sheet along a series of spaced apart rows and columns;

training the individual shape memory alloy actuators to a predetermined state;

laying out a thin-film network of addressable heating elements onto the sheet for selectively activating the shape memory alloy actuators; and

sealing the side edges of the sheet to form a shape memory alloy actuator array.

65. The method as recited in claim 64 wherein the plurality of shape memory alloy actuators are formed in side by side pairs.

66. The method as recited in claim 64 wherein the spaced apart rows form connecting rings to support relative movement of the shape memory alloy actuator array.

67. The method as recited in claim 64 wherein the spaced apart columns generally define the lateral portions of the shape memory alloy actuators.

68. The method as recited in claim 64 wherein the shape memory alloy actuators are trained to expand when heated.

69. The method as recited in claim 64 wherein the shape memory alloy actuators are trained to contract when heated.

70. The method as recited in claim 64 further comprising the step of selecting another thin-film sheet of shape memory alloy material to provide for an overlapping first and a second thin-film sheet wherein the shape memory alloy actuators formed in the first thin-film sheet are trained to expand when heated and the shape memory alloy actuators formed in the second thin-film sheet are trained to contract when heated.

71. The method as recited in claim 70 wherein the first and second thin-film sheet of shape memory alloy material are formed of NiTi.

72. The method as recited in claim 64 further comprising the step of connecting the network of addressable heating elements to a microprocessor

unit for selectively activating a combination of at least one shape memory alloy actuator.

~~73. The method as recited in claim 64 wherein the thin-film sheet of shape memory alloy material is NiTi.~~

Add c57